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Contributions to the Mesozoic flora of the Atlantic coastal plain— VI. Georgia

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No fossil plants have been specifically recorded from the coastal plain of Georgia, although several Eocene plant localities are mentioned by McCallie in his Report on the Underground Waters of Georgia* and one of the following Cretaceous localities is mentioned by Veatch in his recent Report on the Clay Deposits of Georgia.† With the exception of this latter locality near Buena Vista in Marion County all of the following localities have been discovered recently by Dr. L. W. Stephenson or the writer.

Both Lower and Upper Cretaceous deposits are present in Georgia, the former, which have thus far proved unfossiliferous, extending entirely across the state along the "fall-line" and the latter extensively developed west of the Ocmulgee River, which is in the central part of the state, being transgressed east of that point by the late Eocene.

These Upper Cretaceous deposits have been divided by Veatch, on lithologic grounds, into five units, which are, from the oldest to the youngest, the Eutaw (= Tuscaloosa formation), Blufftown, Cusseta, Renfroes, and Providence. They emphasize slight alterations in conditions of sedimentation whereby beds predominantly of sand alternate with marl, the Blufftown and Renfroes phases representing the latter type of sediments. These lithologic phases are fairly well defined in the western part of the state but merge toward the eastward into an indivisible series of sands with local clay lenses, for the most part unfossiliferous. The geology of this area, no doubt with a revised nomenclature, will be published shortly by Dr. Stephenson, so that the foregoing very brief outline will suffice in the present connection.

Determinable fossil plants have been collected from the following five localities:

*Geol. Surv. Georgia, Bull. 15: 36, 336, 347. 1908.

†Geol. Surv. Georgia, Bull. 18: 88. 1909.

1. *McBride's Ford*.—This locality is in the basal part of the Tuscaloosa formation, on the left bank of Upatoi Creek, about 10 miles southeast of Columbus, in Chattahoochee County. The plants were all collected from one small clay lens and include the following species:

<i>Andromeda cretacea</i> Lesq?	<i>Juglans arctica</i> Heer?
<i>Andromeda Wardiana</i> Lesq.	<i>Magnolia Boulayana</i> Lesq.
<i>Androvettia</i> sp. nov.	<i>Magnolia Capellinii</i> Heer.
<i>Aralia</i> sp. nov.	<i>Manihotites</i> sp. nov.
<i>Brachyphyllum macrocarpum</i>	<i>Menispermities</i> sp. nov.
Newb.	<i>Paliurus</i> sp. nov.
<i>Cinnamomum Heerii</i> Lesq.?	<i>Salix flexuosa</i> Newb.
<i>Cinnamomum intermedium</i>	<i>Sequoia Reichenbachii</i> (Gein.)
Newb.	Heer.
<i>Eucalyptus angusta</i> Velen.	<i>Tumion carolinianum</i> Berry?
<i>Ficus ovatifolia</i> Berry.	<i>Zizyphus</i> sp. nov.

The *Sequoia* and *Androvettia* are the most abundant forms and the horizon indicated by the general facies of the foregoing 19 species is one homotaxial with the Tuscaloosa formation of Alabama, the Black Creek formation of the Carolinas, the Magothy formation of the northern coastal plain, and the Dakota-Woodbine formations of the western Gulf and interior.

2. *Broken Arrow Bend*.—This locality is on the left bank of the Chattahoochee River about 13 miles below Columbus in Chattahoochee County, and the flora, as at the preceding locality, comes from small clay lenses near the base of the Tuscaloosa formation. The following species have been recognized:

<i>Malapoenna horrellensis</i> Berry?	<i>Salix flexuosa</i> Newb.
<i>Phragmites Prattii</i> Berry.	<i>Sequoia Reichenbachii</i> (Gein.)
<i>Salix eutawensis</i> Berry.	Heer.

The *Sequoia* is characteristic and is the most abundant form present. The horizon indicated is the same as in the preceding case.

3. *Chimney Bluff*.—This locality is on the left bank of the Chattahoochee River about 22 miles below Columbus and still in Chattahoochee County. The plants from this locality are near

the top of the Tuscaloosa formation and include the following species:

<i>Araucaria bladenensis</i> Berry.	<i>Salix flexuosa</i> Newb.
<i>Araucaria Jeffreyi</i> Berry.	<i>Salix Lesquereuxii</i> Berry.
<i>Ficus crassipes</i> Heer.	<i>Sequoia Reichenbachii</i> (Gein.)
<i>Ficus Krausiana</i> Heer.	Heer.

The *Sequoia* is rare at this outcrop and *Araucaria bladenensis* is the most abundant form. The indicated horizon does not differ greatly from that of the preceding localities.

4. *Near Buena Vista*.—This locality is in a gully along the Buena Vista-Tazewell road, about 6 miles northeast of the former town in Marion County. The horizon is that of the so-called Cusseta sands and the following identifiable species, based on poor and scattered material, indicate a flora not appreciably different from the preceding:

<i>Andromeda Novae-Caesareae</i> Hollick.	<i>Manihotites</i> sp. nov. (same as at McBride's Ford).
<i>Araucaria bladenensis</i> Berry.	Monocotyledon, gen. et sp. nov.
<i>Eucalyptus angusta</i> Velen.	(common to the Black Creek and Tuscaloosa formations).
<i>Ficus</i> sp. nov.	

5. *Near Byron*.—This locality is in a cut of the Central of Georgia Railway about 1.5 miles northeast of Byron in Houston County. The specimens are few and poor but point to a correlation with the Cusseta sands near Buena Vista. The following have been identified, of which the *Cunninghamites* is the most abundant:

<i>Araucaria Jeffreyi</i> Berry.	<i>Dryopteris</i> sp. nov.
<i>Cunninghamites elegans</i> (Corda) Endl.	

When this Upper Cretaceous flora, which consists of but 32 determinable species, is compared with allied floras one is struck with its paucity. For example, the Tuscaloosa flora of Alabama probably contains about 200 species, the Black Creek flora of the Carolinas about 100 species and the Magothy flora considerably more than 100 species. It is evident that the Georgia flora presents but a meager picture of the contemporaneous vegetation of the Piedmont area of Georgia. Another noticeable feature is

the coriaceous nature of most of the leaves. The conifers, which are among the slowest plants to succumb to maceration, are the most abundant types, and the various andromedas, magnolias, and lanceolate leaves of *Ficus* are also very resistant. The conclusion is obvious that all of the more delicate plant remains that floated into the Cretaceous sea were destroyed, and this is corroborated by the character of the sediments, which are predominantly sandy and indicate deposition in shallow much agitated waters. Possibly the Cretaceous coast-line in this region was not broken by any re-entrants of any size, which usually offer exceptional opportunities for the formation of bars and lagoons and the resulting mud-flats, which furnish such excellent facilities for the preservation of the terrestrial vegetation supplied by the tributary rivers. We know that vegetable matter was abundant in these Cretaceous waters from the lignitic character of many of the sands and from the dark carbonaceous clays, but the bulk of it was evidently thoroughly triturated and comminuted before entombment. Possibly too, subsequent erosion of the landward margins of the sediments may account for the absence of land plants, since at McBride's Ford near the landward margin of the deposits they are so much more abundant than at any of the other localities.

These thirty-two Georgia Cretaceous species are distributed among seventeen families in fifteen orders. They include a single polypodiaceous fern and seven species of conifers, most of the latter apparently referable to the Araucarieae, although the relatively primitive Taxaceae are represented by a species of *Tumion*. There are two monocotyledons of little significance and twenty-two dicotyledons of various affinities, including four figs, three willows, three andromedas, two magnolias, and two cinnamomums.

Perhaps the most remarkable form collected is a new species of Euphorbiaceae, very similar to the modern tropical genera *Jatropha* and *Manihot*. These leaves are of immense size and are represented in the collections by the two nearly complete leaves, restorations of which are here figured, and by a number of fragments. This species, which is unlike anything previously known either in this country or abroad, may be briefly characterized as follows:—

***Manihotites georgiana* gen. et sp. nov.**

Leaves large, 36 cm. to 48 cm. in diameter, palmately and deeply lobate, the main lobes dichotomously sublobate. Base probably peltate. Margins entire, more or less undulate. Texture coriaceous. Venation coarse, consisting of five or six stout primaries diverging at acute angles from the top of the petiole, these forking dichotomously about five or six centimeters above their base at angles of from 30° to 50° ; the branches sometimes again forking dichotomously in a distance of from four to six centimeters, or simple, or with branches clearly subordinate in

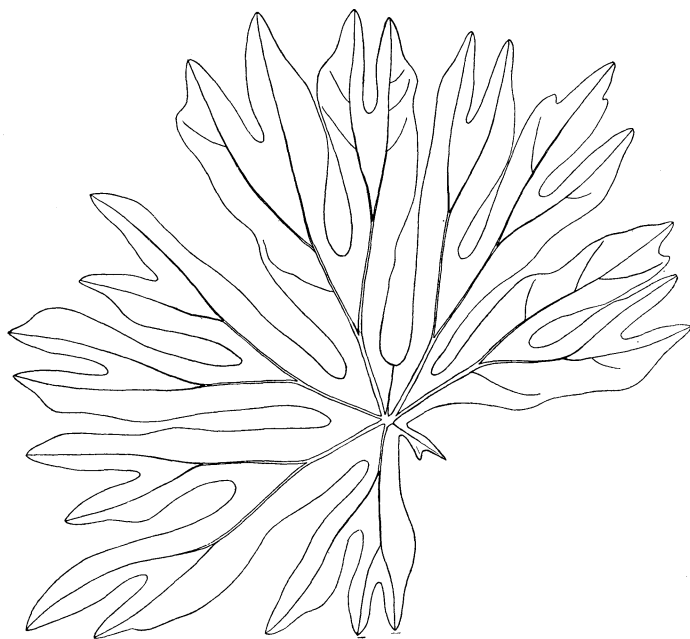


FIGURE 1. Restoration of *Manihotites georgiana* Berry, from the Upper Cretaceous of Georgia. ($\times \frac{1}{4}$)

size and running to the apex of a subordinate lobe. There are a sparse number of relatively fine secondaries diverging at angles of about 45° or more and apparently camptodrome. The deep and narrow but rounded sinuses approach to within three to five centimeters of the base and divide the leaf into five or more major lobes and these are subdivided by more or less deep sinuses of a similar character into inequilateral, ovate-lanceolate, obtusely pointed, subordinate lobes. [FIGURES 1 and 2.]

There was considerable variation in the lobation of these leaves as is shown by the specimens figured. It seems very probable that these two leaves were from a single plant, since it is very unlikely that two separate leaves of this size and of the same degree of preservation would have found their way out into the Cretaceous sea and have come to rest within a few inches of one another in this very small clay lens which was not over ten feet in diameter and which was several miles from the Cretaceous shore. The one leaf has the lobes broadly rounded and each main lobe divided

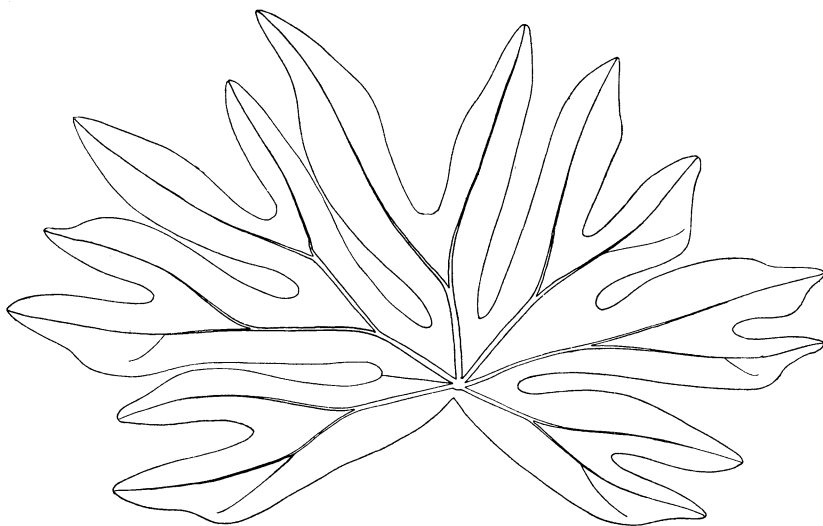


FIGURE 2. Restoration of a second nearly complete leaf of *Manihotites georgiana* Berry, from the Upper Cretaceous of Georgia. ($\times 1/3.33$)

into two nearly equal subordinate lobes, while in the other leaf these subordinate lobes are subdivided in a like manner and some of these subdivisions are again subdivided.

The only fossils that are at all comparable to this species are, first, the forms from the Raritan formation in New Jersey described by Professor Newberry as *Fontainea grandifolia*;^{*} second, those named *Haliserites Reichii* by Sternberg[†] from their supposed algal nature, although they are clearly angiospermous as Rothpletz has

^{*}Newberry, Fl. Amboy Clays 96. pl. 45. f. 1-4. 1896.

[†]Sternberg, Fl. Vorwelt 2: 34. pl. 24. f. 7. 1833.

recently pointed out.* The latter fossils come from the Cenomanian of Saxony, while a third form, suggestive of the Georgia fossils from the Cenomanian of Bohemia, is called by Velenovsky *Aralia furcata*.†

The Georgia plant is, however, entirely distinct from any of these forms and it has been compared with a large amount of recent material such as *Jatropha*, *Cecropia*, various tropical *Araliaceae*, etc. It proves to be closest, however, to certain species of the genus *Manihot* of Adanson and it is believed that the remarkably variable leaves in the latter genus furnish a satisfactory clue to the relationship of this Cretaceous species, since no other comparable modern genus has leaves with similar wavy margins and inequilateral rounded lobes. This relationship is indicated in the generic name chosen for the Georgia fossils. The modern genus *Manihot* has between eighty and one hundred species in the American tropics.

An effort to picture accurately the environment of this flora is beset with unusual difficulties, as may be imagined from what has already been said. It is safe to assume that the climate was mild and humid, the latter being probably the most important factor aside from the absence of frost. That the temperature was not tropical in character we may assume from the manner in which this flora preserves its integrity when traced northward over a good many degrees of latitude. Judged by the facts of the present-day geographical distribution of plants, this flora presents an antipodean facies with its *Eucalyptus* and abundant *Araucarieae*, but this is only another way of emphasizing its Mesozoic character, since the abundant evidence at our command shows that both of these types were practically cosmopolitan in the Mesozoic. Another feature, strange in the eyes of modern plant geographers is the curious mingling of forms which in the existing flora are to a greater or less extent climatically segregated. Willows and walnuts growing with figs, eucalypts, laurels, and araucarias would indeed be anomalous in the present flora, but this and similar associations are familiar enough in fossil floras not only during the Mesozoic but well into the Cenozoic.

*Rothpletz, Zeits. Deutsch. Geol. Gesells. 48: 904. 1896.

†Velenovsky, Fl. Böhm. Kreidef. 3: 13. pl. 4. f. 1. 1884.

Even though no close comparisons with modern ecological groups are possible it would seem that if the Upper Cretaceous flora were existing at the present time it would be included by ecological botanists under that somewhat elastic head which Schimper calls "temperate rain-forests." In no other modern plant associations do we find that commingling of temperate and tropical types that we find in certain present-day temperate rain-forests, as for example those of southern Chile, southern Japan, northern Australia, and New Zealand. In the last mentioned we find aralias, laurels, *Cinnamomum*, *Magnolia*, and *Sterculia* associated with *Quercus*, *Fagus*, *Gleichenia*, *Dryopteris*, *Dicksonia*, etc. In some respects this type in New Zealand is the most tropical in its facies and more like our eastern American Upper Cretaceous floras than any other existing flora. In New Zealand conifers are abundant and include forms with reduced leaves like *Libocedrus* and *Dacrydium*, as well as forms with broad leaves like *Dammara*, *Podocarpus*, and *Phyllocladus*. Dicotyledonae are numerous and varied, including between 100 and 150 species, among which forms of Myrtaceae, Lauraceae, Proteaceae, etc., with coriaceous leaves are prominent. The undergrowth is rich in tree-ferns and various genera of Araliaceae.

When this modern flora is compared element for element with the coastal plain Cretaceous flora many differences naturally become apparent, nevertheless the resemblance between the two is remarkable. In the coastal plain Cretaceous floras the narrow or scale-leaved conifers are represented by *Sequoia*, *Moriconia*, *Brachyphyllum*, and *Widdringtonites*. *Dammara* represents the broad-leaved araucarias, while *Androvettia* and *Protophyllocladus* represent the modern *Phyllocladus*. The dicotyledons are numerous and varied with a mixing of temperate and tropical types and with numerous coriaceous forms belonging to a number of the same families as do the New Zealand plants. Aralias are common in the former as in the latter. That the Cretaceous rainfall was plentiful may be inferred, not only from the species of plants preserved, but also from the formation of dripping points on various leaves, this feature being especially emphasized in the Tuscaloosa flora of Alabama, although it is often obscured by the facility with which these long slender tips are broken off by current action before entombment.

The present brief note is in the nature of an abstract of a full discussion of the Georgia flora which will be published by the U. S. Geological Survey, to the Director of which the writer is indebted for the permission to publish the present paper, setting forth such conclusions as seemed to be of especial botanical interest.

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